

## **CONNECTOR ROD**

### **TECHNICAL FIELD OF THE INVENTION**

[0001] This patent discloses and claims a useful, novel, and unobvious invention for a connector rod for connecting a vehicle steering mechanism to a vehicle wheel assembly in the automotive field.

### **BACKGROUND**

[0002] The suspension of a vehicle is typically designed to keep the vehicle's wheels in firm contact with the road and to provide a comfortable ride for the passengers. The vehicle suspension typically includes springs and shock absorbers that allow the vehicle wheels to move up and down independently of the vehicle. In this way, the wheels react to uneven driving surfaces with minimal reaction transferred to the rest of the vehicle. Connector rods (also known as "tie rods") connect a vehicle's steering mechanism to the vehicle's wheel assembly.

[0003] When the wheel assembly moves up and down, the end of the connector rod attached to the wheel assembly must move up and down as well. Since the opposite end of the connector rod is attached to the steering mechanism, that end does not move up and down. Consequently, the connection between the connector rod and the steering mechanism must allow the connector rod to pivot vertically with respect to the vehicle steering mechanism.

[0004] Further, the connection between the connector rod and the steering mechanism must also accommodate movement in the horizontal direction. As the wheel assembly pivots to turn the vehicle, the point of connection between the connector rod and the wheel assembly travels along an arcuate path. This happens because the connection between the connector rod and the wheel assembly is offset from the pivot axis of the wheel assembly. This is functionally necessary to facilitate

transfer of linear movement from the steering mechanism to pivotal movement of the wheel assembly. Movement along this arcuate path causes the connection between the connector rod and the wheel assembly to move slightly forward and backward as the wheel assembly is turned. Throughout this movement, the angle between the connector rod and the wheel assembly in the horizontal plane changes. Therefore, the connection between the connector rod and the steering mechanism must accommodate pivotal movement of the connector arm in relation to the steering mechanism both vertically and horizontally.

**[0005]** In the past, this connection has been accomplished by using a ball joint which allows a wide degree of pivotal movement in either direction. However, the amount of movement in the horizontal plane is slight compared to the movement in the vertical plane. Due to the cost and weight factors associated with ball joints, there is a need for a connector rod with a simplified connection between the connector rod and the steering mechanism which will allow broad pivotal movement in the vertical direction as well as allowing limited pivotal movement in the horizontal direction.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0006]** Figure 1 is a perspective view of a connector rod of the present invention;

**[0007]** Figure 2 is a perspective view of a portion of a vehicle wheel support structure including the vehicle steering mechanism and the vehicle wheel assembly;

**[0008]** Figure 3 is a front view of the connector rod interconnecting the vehicle wheel assembly and the vehicle steering mechanism shown when there is no relative movement between the wheel assembly and the steering mechanism;

**[0009]** Figure 4 is a front view of the connector rod interconnecting the vehicle wheel assembly and the vehicle steering mechanism shown when the wheel assembly has moved in a first plane with respect to the vehicle steering mechanism;

**[0010]** Figure 5 is a front view of the connector rod;

**[0011]** Figure 6 is a partial sectional top view of the connector rod;

**[0012]** Figure 7 is a top view of the connector rod interconnecting the vehicle wheel assembly and the vehicle steering mechanism shown when the vehicle wheels are aligned for straight line motion of the vehicle;

**[0013]** Figure 8 is a top view of the connector rod interconnecting the vehicle wheel assembly and the vehicle steering mechanism shown when the vehicle wheels are angled for a left turn;

**[0014]** Figure 9 is a top view of the connector rod interconnecting the vehicle wheel assembly and the vehicle steering mechanism shown when the vehicle wheels are angled for a right turn;

**[0015]** Figure 10 is a perspective view of the first end of a second embodiment of the connector rod of the present invention; and

**[0016]** Figure 11 is a top sectional view of the first end of the second embodiment shown mounted to the vehicle steering mechanism.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

**[0017]** The following description of the preferred embodiments of the invention is not intended to limit the scope of the invention to these preferred embodiments, but rather to enable any person skilled in the art to make and use the invention.

**[0018]** Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a connector rod for linking a vehicle steering mechanism to a vehicle wheel assembly is shown generally at **10**. The connector rod **10** includes a first end **12** connected to the vehicle steering mechanism **14**, a second end **16** connected to the vehicle wheel assembly **18**, and a shaft portion **20** interconnecting the first and second ends **12**, **16**.

**[0019]** Referring to Figure 1, the first end **12** is adapted for pivotal connection to the vehicle steering mechanism **14**. The pivotal connection allows the connector rod **10** to pivot in a first plane relative to the vehicle steering mechanism **14**. Generally, the first plane is vertical and must be accommodated to allow vertical movement of the vehicle wheel assembly **18** as the vehicle drives over uneven surfaces. The suspension of a vehicle is typically designed to keep the vehicle's wheels in firm contact with the road and to provide a comfortable ride for the passengers. The vehicle suspension typically includes springs and shock absorbers that allow the vehicle wheels to move up and down independently of the vehicle. In this way, the wheels react to uneven driving surfaces with minimal reaction transferred to the rest of the vehicle.

**[0020]** Referring to Figures 2 through 4, in a vehicle, connector rods **10** (also known as "tie rods") connect a vehicle steering mechanism **14** to the vehicle wheel assembly **18**. Because the wheel assembly **18** moves up and down independently of the vehicle, and more importantly the steering mechanism **14**, the connector rods **10** need to be able to pivot. When the wheel assembly **18** moves up and down, the second end **16** of the connector rod **10** must move up and down as well. Since the first end **12** of the connector rod **10** is attached to the steering mechanism **14**, the first end **12** does not move up and down. The connection of the first end **12** of the

connector rod **10** to the vehicle steering mechanism **14** is such to allow the connector rod **10** to pivot vertically with respect to the vehicle steering mechanism **14** as the second end **16** of the connector rod **10** moves up and down with the vehicle wheel assembly **18**.

**[0021]** In the preferred embodiment, the second end **16** of the connector rod **10** includes an externally threaded section **34** for threaded engagement with a ball joint **36**. It is to be understood however, that the connector rod **10** can be fastened or mounted to the ball joint **36** by other methods. The ball joint **36** is in turn mounted to the end of the pivot arm **32**. The ball joint **36** allows pivotal movement of the second end **16** of the connector rod **10** in both the vertical and horizontal directions. The second end **16** could be mounted to the pivot arm **32** by other suitable methods that allow pivotal movement of the second end **16** of the connector rod **10** in both the vertical and horizontal directions.

**[0022]** Referring to Figures 3 and 5 the vehicle wheel assembly **18** can move up and down between a high point, shown in Figure 3, and a low point, as shown in Figure 4. As the second end **16** of the connector rod **10** moves between the high point and the low point, the connector rod **10** must pivot radially about the first end **12** that is fixed with relation to the vehicle. The range of movement is typically on the order of approximately 60 degrees as shown at **21**.

**[0023]** Referring to Figures 5 and 6, in the preferred embodiment, the first end **12** includes an aperture **22** extending through the connector rod **10** for receiving a corresponding support pin **24** that is mounted to the vehicle steering mechanism **14**. The support pin **24** is oriented orthogonal to the connector rod **10** such that when the connector rod **10** is mounted to the pin **24**, the connector rod **10** can pivot vertically about the pin **24**.

[0024] Referring to Figures 6 through 9, the second end **16** of the connector rod **10** is mounted pivotally to the vehicle wheel assembly **18**. The vehicle wheel assembly **18** preferably includes a pivotal wheel hub **26** for supporting a wheel **28**, a knuckle **30** mounted to the wheel hub **26**, and a pivot arm **32** extending outward from the knuckle **30**. The pivot arm **32** preferably extends outward from the knuckle **30** so that the end of the pivot arm **32** is located away from the pivot point of the wheel assembly **18**. Therefore, when the end of the pivot arm **32** is moved, the wheel assembly **18** pivots. The second end **16** of the connector rod **10** is pivotally mounted to the end of the pivot arm **32** to transfer motion of the steering mechanism **14** through the connector rod **10** to cause the wheel assembly **18** to pivot, thereby turning the vehicle.

[0025] As the pivot arm **32** moves, the distal end of the pivot arm travels along an arcuate path, shown at "P" in Figures 7, 8 and 9, about the pivot axis of the wheel assembly **18**. Movement along this arcuate path causes the second end **16** of the connector rod **10** to move slightly forward and backward as the wheel assembly **18** is turned. As the pivot arm **32** moves through the arcuate path, the angle between the connector rod **10** and the pivot arm **32** in the horizontal plane changes.

[0026] The connector rod **10** includes a shaft portion **20** interconnecting the first and second ends **12**, **16**. The shaft portion **20** is preferably formed from a flexible material to allow the connector rod **10** to deform in a second plane, approximately orthogonal to the first plane, in response to movement of the second end **16** of the connector rod **10** in the second plane. As the knuckle **30** moves to pivot the wheel assembly **18**, the second end **16** of the connector rod **10** follows the arcuate path "P" about the pivot point of the wheel assembly **18**. This causes the second end **16** of the connector rod **10** to move forward and backward slightly as the

wheel assembly **18** pivots. The first end **12** of the connector rod **10** is only allowed to pivot in a first plane that is vertical with relation to the vehicle, so the connector rod **10** must compensate for the movement of the second end **16** in the horizontal direction.

[0027] As the second end **16** of the connector rod **10** moves between the forward extreme position and the rearward extreme position, the connector rod **10** must pivot radially about the first end **12** that is fixed with relation to the vehicle. The range of movement is approximately 5 to 8 degrees or less as shown at **42** in Figure 6. To accommodate for the horizontal movement of the second end **16** of the connector rod **10**, the shaft portion **20** of the connector rod **10** is flexible. This allows the second end **16** of the connector arm to move in the horizontal plane even though the first end **12** of the connector rod **10** cannot move or pivot in that direction. Preferably, the shaft portion **20** is made from fiber-reinforced compounds or spring steel. It is to be understood, however, that the shaft portion **20** can be formed from other materials displaying similar flexibility and strength properties.

[0028] Referring to Figures 10 and 11, rather than having a flexible shaft portion **20**, the first end **12a** of the connector rod **10a** can alternatively be mounted to allow total pivotal freedom in the vertical plane as well as allowing limited pivotal movement in the horizontal plane. In this second embodiment the first end **12a** includes an aperture **22a** extending through the connector rod **10** for receiving a corresponding support pin **24a** that is mounted to the vehicle steering mechanism **14a**. The pin **24a** is oriented orthogonal to the connector rod **10a** such that when the connector rod **10a** is mounted to the support pin **24a**, the connector rod **10a** can pivot vertically about the support pin **24a**.

[0029] In the second embodiment, the first end **12a** includes a spherical bearing **44** disposed between the first end **12a** of the connector rod **10a** and the support pin **24a**. The spherical bearing **44** allows a modest amount of pivotal movement of the connector rod **10a** in relation to the steering mechanism **14a**. The amount of pivotal movement allowed by the spherical bearing **44** is on the order of approximately 12 degrees. This is enough to accommodate the horizontal movement of the connector rod **10a** due to movement of the second end **16**. Typically, the amount of pivotal movement in the horizontal plane is on the order of 5 to 8 degrees, well within the 12 degrees that can be accommodated by the spherical bearing **44**.

[0030] The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. The foregoing discussion discloses and describes a preferred embodiment of the invention. One skilled in the art will readily recognize from such discussion, and from the accompanying drawings and claims, that changes and modifications can be made to the invention without departing from the true spirit and fair scope of the invention as defined in the following claims.